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APPLICATION FOR UNITED STATES LETTERS PATENT

INVENTOR(S):	SRINIVAS S. PITLA VIPEN KHETARPAL
TITLE:	PISTON ANTI-ROTATION MECHANISM FOR A SWASH PLATE COMPRESSOR
ATTORNEY(S):	LAWRENCE G. ALMEDA STEVEN L. OBERHOLTZER BRINKS HOFER GILSON & LIONE P.O. BOX 10395 CHICAGO, ILLINOIS 60610 (734) 994-6285

PISTON ANTI-ROTATION MECHANISM FOR A SWASH PLATE COMPRESSOR

BACKGROUND OF THE INVENTION

[0001] The present invention relates to a piston anti-rotation mechanism for a reciprocating swash plate compressor assembly.

[0002] Swash plate compressors are known in the art and are widely used in many industries, such as for climate control systems for motor vehicles in the automotive industry. Typically, a swash plate compressor includes a compressor housing which is configured to receive a rotatable driveshaft and a swash plate angularly disposed about the driveshaft. The compressor further includes a number of pistons which are slideably attached to the swash plate so that the swash plate linearly moves the piston within the compressor as the swash plate rotationally moves about its axis of rotation.

[0003] In most situations, it is undesirable for the piston to rotatably move in its bore within the compressor housing. However, in many situations, the swash plate which slidably attaches to the piston drags the piston to rotate as well as linearly move within the compressor. Rotation of the piston causes an undesirable contact with the swash plate, e.g., an undesirable contact of the swash plate and a skirt of the piston. Such contact may cause damage to the piston. Several manufacturers of swash plate compressors have been challenged in producing anti-rotational features of pistons within the compressor assembly, while maintaining high efficiency and low costs. Current swash plate compressor technology calls for further improvements to be made in such compressors.

BRIEF SUMMARY OF THE INVENTION

[0004] The present invention provides a swash plate compressor assembly having a piston anti-rotation mechanism which prevents pistons disposed within the compressor assembly from rotating therein. The assembly generally includes a front head having grooves formed within an inner wall and a cylinder block having bores formed therein. The cylinder block attaches to the front head so that the grooves are aligned adjacently with the bores to allow the pistons to be disposed simultaneously within the bores and the grooves. Each piston includes a body and a skirt extending from the body. The body complements the bore and the skirt complements the groove so that the piston can slide within the compressor assembly. The body and the groove have differing axes of rotation which are offset from each other. The offset relationship of the axes and the complementing dimensions of the piston relative to the groove and the bore define the anti-rotation mechanism which prevents the piston from rotating within the compressor assembly as the piston moves along the groove and the bore.

[0005] The swash plate compressor assembly of the present invention also provides a cost advantage and improved quality control in manufacturing the assembly. In one embodiment of the present invention, the groove and skirt are merely cylindrically shaped requiring no complex shapes formed by milling or broaching operations. A typical boring machine can easily bore the grooves saving time and, in turn, costs.

[0006] These and other advantages, features and benefits of the invention will become apparent from the drawings, detailed description and claims which follow.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] Figure 1 is a side cross-sectional view of a swash plate compressor assembly having a piston anti-rotation mechanism in accordance with one embodiment of the present invention;

[0008] Figure 2a is a top view of a front head of the compressor assembly of Figure 1;

[0009] Figure 2b is an enlarged view of an anti-rotation groove of the front head shown in Figure 2a;

[0010] Figure 3 is a front perspective view of a cylinder of the compressor assembly in Figure 1;

[0011] Figure 4 is a side perspective view of a first embodiment of an anti-rotation piston of the compressor assembly;

[0012] Figure 5 is another side view of the anti-rotation piston in Figure 4;

[0013] Figure 6a is a side environment view of a plurality of anti-rotation pistons disposed in the front head of the compressor assembly;

[0014] Figure 6b is a cross-sectional side view of the compressor assembly shown in Figure 6a taken along lines 6-6;

[0015] Figure 6c is a side view of the anti-rotation piston shown in Figure 4 disposed along the anti-rotation groove shown in Figure 2b;

[0016] Figure 6d is another cross-sectional side view of the compressor assembly in Figure 6a taken along lines 6-6 depicting axes B and C of the anti-rotation piston.

[0017] Figure 7a is a top environmental view of the front head of the compressor assembly having the anti-rotation piston disposed therein;

[0018] Figure 7b is an enlarged view of the anti-rotation piston shown in Figure 7a;

[0019] Figure 8 is a side view of a second embodiment of the anti-rotation piston in accordance with the present invention ;

[0020] Figure 9 is a top view of the anti-rotation piston shown in Figure 8;

[0021] Figure 10 is another side view of the second embodiment of the anti-rotation piston;

[0022] Figure 11 is a cross-sectional view of the compressor assembly housing the second embodiment of the anti-rotation piston;

[0023] Figure 12a is a top cross-sectional view of the compressor assembly shown in Figure 11; and

[0024] Figure 12b is an enlarged view of the piston anti-rotation mechanism shown in Figure 12a.

DETAILED DESCRIPTION OF THE INVENTION

[0025] Figure 1 illustrates swash plate compressor assembly 10 having a piston anti-rotation mechanism. As shown, compressor assembly 10 includes a rear head and front head 13 having driveshaft side 16 and inner wall 20 extending from driveshaft side 16 to open end 23 defining crank case 26. Figures 1 - 2b depict inner wall 20 having a plurality of anti-rotation grooves 30 formed thereon and extending to open end 23. Figures 1 and 3 depict cylinder 33 having front and rear ends 36, 37. Front end 36 includes a plurality of piston-receiving bores 40 formed therethrough, wherein front end 36 engages with open end 23 so that one of the anti-rotation grooves 30 is adjacent one of the piston-receiving bores 40. As shown,

assembly 10 further includes driveshaft 43 having first and second portions 46, 47 and defining axis A of rotation. In this embodiment, driveshaft 43 is rotatably disposed through driveshaft side 16 and at the center of front head 13 so that first portion 46 is disposed within crank case 26. Swash plate 50 is angularly disposed about the first portion 46 of driveshaft 43 in crank case 26. This allows swash plate 50 to be angularly rotated relative to assembly 10 as driveshaft 43 rotates about axis A.

[0026] Figure 4 illustrates anti-rotation piston 53, a plurality of which are configured to be slideably disposed in compressor assembly 10. As shown, anti-rotation piston 53 includes body 56 and skirt 60 extending from body 56. Body 56 has first radius 63 of curvature and first and second ends 66, 67. As shown, body 56 complements piston-receiving bore 40 of cylinder 33 so that body 56 is slideably moveable within bore 40 when disposed in assembly 10. As shown, skirt 60 extends from second end 67 and has an arcuate outer surface 70 complementing groove 30 of inner wall 20 so that skirt 60 is slideably moveable along the groove when disposed in assembly 10. Skirt 60 further has a second radius 73 of curvature which is greater than first radius 63 of curvature of body 56. Second radius 73 and first radius 63 are in non-concentric or in offset relationship with each other so that body 56 and skirt 60 have differing axes of rotation. Preferably, body 56 is configured to have axis of rotation B located within piston 53, and skirt 60 is configured to have axis of rotation C located within piston 53 between inner wall 20 and axis of rotation B. The offset relationship of the axes and the complementing dimensions of the piston relative to the groove and the bore defines the anti-rotation mechanism. In operation of compressor assembly 10, this prevents piston 53 from rotating therein.

[0027] As shown in Figures 4 and 5, skirt 60 forms plate-receiving slot 76 through which swash plate 50 slidably rotates to slideably move piston 53 along groove 30. Plate-receiving slot 76 is defined by first and second walls 78, 79 which are integrally connected by back wall 80. As shown, first wall 78 has first shoe pocket 83 formed thereon, and second wall 79 has second shoe pocket 84 formed thereon. As shown, shoe 86 is disposed in plate-receiving slot 76 within first and second shoe pockets 83, 84. Thus, swash plate 50 is slidably received between pairs of in shoe 86 during normal operation of assembly 10.

[0028] Figures 6a illustrates anti-rotation piston 53 disposed in compressor assembly 10. As shown in Figure 6b and 6c, skirt 60 is slidably moveable along anti-rotation groove 30 and body 56 is slidably moveable within piston-receiving bore 40. Arcuate outer surface 70 complements groove 30 which allows piston 53 to slidably move along groove 30. Body 56 complements piston-receiving bore 40 such that piston 53 may also slide within bore 40. In operation, swash plate 50 is angularly rotated about axis A of rotation and is slidably attached to shoe 86 in plate-receiving slot 76 so that, as swash plate 50 rotates about axis A of rotation, angular movement of plate 50 allows piston 53 to linearly move along groove 30 and bore 40. As shown in Figures 6b and 7a-7b, piston 53 is prevented from rotating about either axis B or axis C, since the axes B, C are in offset relationship as body 56 complements bore 40 and skirt 60 complements groove 30. This prevents swash plate 50 from contacting bridge or back wall 80, thereby increasing the longevity of each of the pistons 53.

[0029] Figures 8 and 9 depict a second embodiment of the piston for the swash plate compressor assembly 10. As shown, anti-rotation piston 153 includes

similar features to anti-rotation piston 53. For example, body 156, skirt 160, first radius 163, first end 166, second end 167, and second radius 173 of anti-rotation piston 153 are similar to body 56, skirt 60, first radius 63, first end 66, second end 67, and second radius 73 of anti-rotation piston 53. As shown in Figure 10, outer surface 170 of skirt 160 has arcuate and planar surfaces. Arcuate surfaces 171, 172 are integrally connected to each other by planar surface 174. As shown, arcuate surfaces 171, 172 complement the dimensions of anti-rotation groove 30 such that arcuate surfaces 171, 172 have the same radius of curvature length as skirt 60, although outer surface 171 does not fully complement groove 130. As a result, anti-rotation piston 153 weighs substantially less than anti-rotation piston 53 of the first embodiment, while maintaining anti-rotation of piston 153 within assembly 10. Although planar surface 174 may not complement groove 130, arcuate surfaces 171 and 172 prevent piston 153 from rotating since its axis of rotation C′ is offset from axis of rotation B′ as shown. Additionally, arcuate surfaces 171 and 172 complement the anti-rotation groove to further prevent rotation of piston 153.

[0030] It has been found that the swash plate compressor assembly of the present invention also provides a cost advantage and quality control in manufacturing the assembly. As depicted in the figures, the grooves of the inner walls are simply formed to have a cylindrical shape which receives the skirt of each piston. This shape of the grooves is relatively simple or easy to form on the inner walls with respect to other complex inner wall shapes formed by milling or broaching operations. With a typical boring machine, the grooves of the inner walls of the present invention are formed in a time efficient manner resulting in cost savings.

[0031] While the invention has been described in terms of preferred embodiments, it will be understood, of course, that the invention is not limited thereto since modifications may be made by those skilled in the art, particularly in light of the foregoing teachings.